LMC International

The Economic Impact of U.S. Soybeans and End Products on the U.S. Economy

Report for:

United Soybean Board and National Oilseed Processors Association

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Research and analysis to inform your business decisions

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Executive Summary

Introduction

The United Soybean Board (USB) and the National Oilseed Processors Association (NOPA) commissioned LMC International (LMC) to undertake research and analysis to quantify the benefit of soybeans to the American economy in terms of:

1. **Economic impact**
2. **Number of people dependent on the sector**
3. **Wages**

and at different levels:

1. **National**
2. **State**
3. **Congressional district**

This study provides the results of that independent analysis.

There have been a handful of studies over the years with the aim of assessing economic impacts of the soybean value chain at the state level. However, this study marks the first industry-coordinated effort to quantify results at the congressional district as well as state level and then to combine the results for a national total.

The value chain

We focused specifically on the **production, distribution and use of soybeans and soybean products**, spanning twelve steps in the value chain: from soybean farming and processing to the delivery of value added by-products to end users or ports of export. We also included the economic impact to the livestock sector of the benefits of using soybean meal as well as a limited coverage of the economic impacts of soybean oil in food production — focusing on edible products that are 100% or nearly 100% soy oil, like bottled oil, margarine and shortening. We estimated the value added through soybean production and at each subsequent step in the value chain.

The results capture:

1. The ***direct*** benefit from these stages.
2. The ***indirect*** benefit from the associated economic and market activities and industries.
3. The ***induced*** benefit from household spending of the income earned from the soy sector.

Research approach

The objective was to develop an up-to-date assessment, using:

- Official, citable data as much as possible.

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- The latest data spanning the 2012/13-2016/17 crop years.
- Interviews with industry participants.
- Best practice in estimating economic benefits.

To perform the analysis, we began by calculating *Direct Impacts* – which is to say, revenues, jobs, and wages directly attributable to the soybean sector. *Indirect* and *induced* impacts were then quantified using economic multipliers derived by the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). The summation of these indirect and induced impacts, along with the direct impacts that were calculated first hand, represents the *Total Impacts*. The totals therefore combine the indirect and induced impacts of the soybean industry with the direct impacts.

The big picture: national results

U.S. total impacts, 2014/15-2016/17 average

- **Economic impact: $115.8 billion**
- **People supported: 357,000**[1]
  - Full-time equivalent paid jobs: 280,000
  - Family members involved: 78,000
- **Wages: $11.6 billion**

Conclusion

➢ **The development over the study period is clear: soybean's support to the U.S. economy is substantial, even in the face of lower commodity prices and efficiency gains in the sector, as the U.S. industry increases production to meet global needs.**

---

[1] USDA NASS' most recent *Census of Agriculture* in the United States indicates that there are roughly 300,000 farms that report any soybean sales. However, one-third of these farms are run by someone whose primary occupation is other than farming, while 50% of all soybean growers derived less than half their income from farming. Even on soybean farms where the owner's primary source of income is farming, a grower's time would be split among other crops. **Throughout this study, all jobs supported are presented on a full-time equivalent basis**, which we define as an individual working 2,000 hours per year. Because of the part-time nature of many growers' soybean-related activities, the full-time equivalent of jobs supported is significantly less than what might be assumed at first blush from the 300,000 farms. In fact, however, **the study's result is actually large for full-time equivalent jobs, in light of all the factors listed here.**

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National Results

Summary

For the average of the three years, 2014/15-2016/17:

- **The total economic impact on the U.S. economy from the soybean sector averaged $115.8 billion per year** (Table 5).
- **357,000 people are supported by the soybean sector, comprising 280,000 paid full-time equivalent jobs and an additional 78,000 family members (beyond the growers themselves) who support and are supported by soybean farming operations** (Table 6).
- **The total wage impact of the sector averaged $11.6 billion.** It is important to note that this values farmer wages (wages that they pay themselves) at their opportunity cost and does not include farm business profits or losses (Table 7).

The economic benefits from soybeans declined markedly in 2015/16, coinciding with a decrease in commodity prices. In 2016/17, however, they rebounded to:

- A total economic impact on the U.S. economy from the soybean sector of $121 billion.
- This is equivalent to more than 0.7% of U.S. GDP (Gross Domestic Product). In some states, the share of the economy is far higher, being upwards of 9% in the Dakotas (Diagram 1).
- 363,000 people were supported by the soybean sector, including 285,000 paid full-time equivalent jobs and an additional 78,000 family members (beyond the growers themselves) who support and are supported by soybean farming operations.
- In 2016, the median average annual wage directly supported by the soybean sector was $44,800, in line with the U.S. median wage of $45,600 and comparing favorably with wages from other sectors in many of the rural communities where the soybean value chain is rooted (Diagram 2).

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Diagram 1: Soy's share of state GDP, 2016

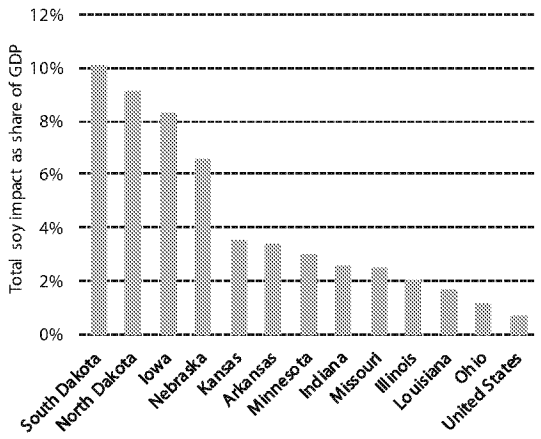
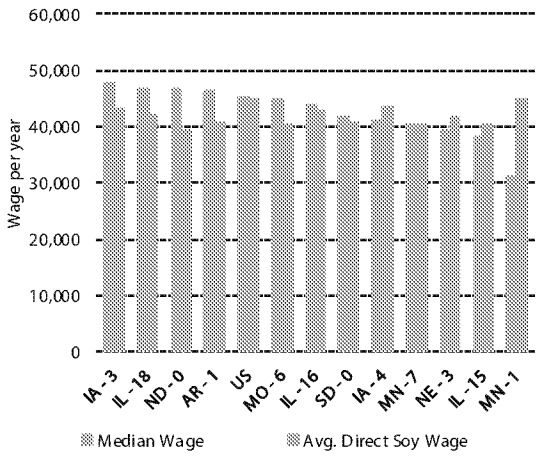


Diagram 2: Soy direct wages vs. median wage by district[2], 2016



In detail

National results are presented graphically for direct impacts in Diagrams 3 and 4 and for total impacts in Diagrams 5 and 6. As mentioned in the introduction, *direct* impacts were modeled manually across 12 steps in the soybean value chain (Table 1), with economic multipliers applied to estimate *total* impacts. A more detailed discussion of these BEA multipliers can be found in the methodology section at the end of this report.

From the diagrams for national results, we observe that:

- Direct economic impacts have hovered pretty consistently around $50 billion per year, while total impacts have trended around $120 billion. This relative consistency over time, as well as the slight drop in 2015/16, can be explained, for the most part, by the offsetting forces of falling commodity prices over the study period and rising volumes (Diagram 7).

- Between 2012/13 and 2016/17, direct employment impacts, including farm family members, increased from 145,000 people supported to 162,000 (Diagram 4). In terms of total employment impacts, these increased from 318,000 people to 363,000. The field side of this equation can be explained largely by increased soy acreage (Diagram 8), while employment effects further downstream can be explained by increased volumes of soy products processed and handled.

- Direct wage impacts meanwhile increased from $2.9 to $3.8 billion, with total wage impacts increasing from $9.4 to $12.2 billion. Intuitively, wage impacts are a function of increased employment impacts, while also reflecting inflationary pressure on wages.

[2] Median wage by district was calculated as median household income divided by 1.3, the average number of wage-earners per household in the United States.

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Diagram 3: DIRECT economic and wage impacts of U.S. soybeans over time

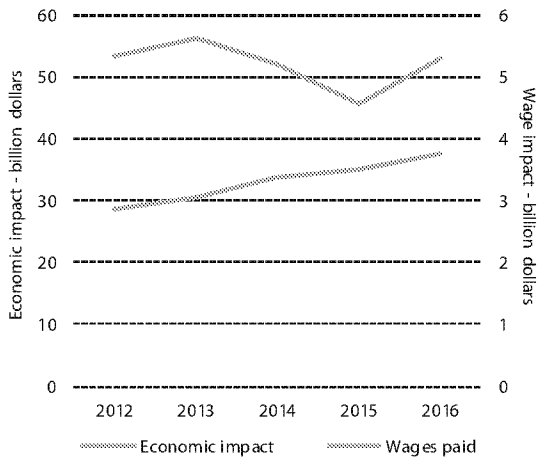

Diagram 4: DIRECT employment impacts of U.S. soybeans over time

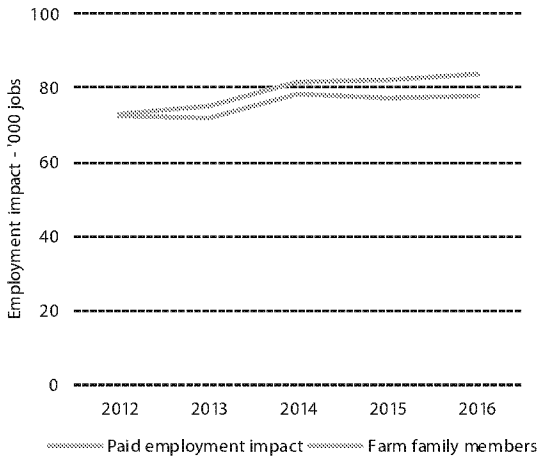

Diagram 5: TOTAL economic and wage impacts of U.S. soybeans over time

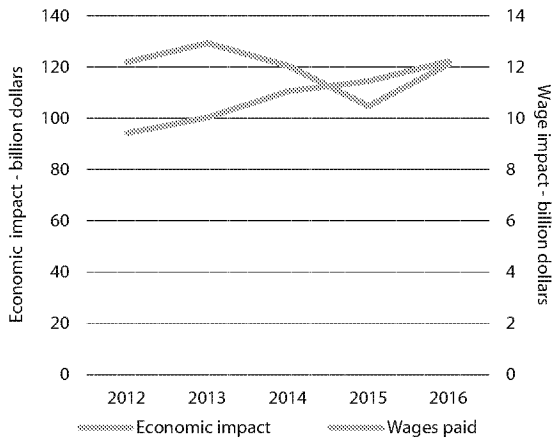

Diagram 6: TOTAL employment impacts of U.S. soybeans over time

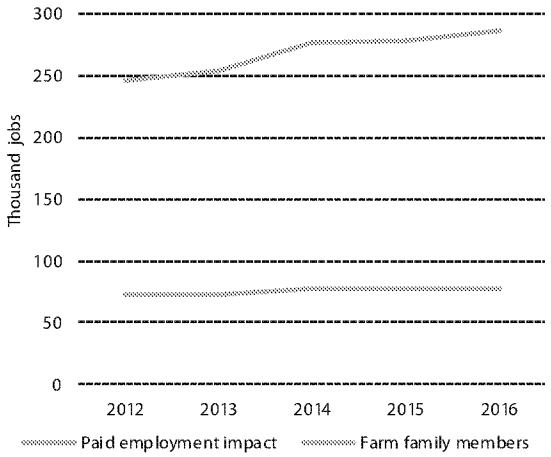

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Table 1: Steps in the U.S. soybean value chain covered in this study [3,4]

Step number	Value chain component	Description	Economic impact	Employment	Wages	Multiplier used
1a	Soybean farming	Production of soybeans by farmers using land and agricultural inputs like seed, fertilizers and crop protection	yes	yes	yes	yes
1b	Farm family members	Unpaid family members who may indirectly support farm operation. Paid family members would be captured under step 2a	captured in soybean farming	yes	captured in soybean farming	no
2	Seed delivery	Delivery of seed to crushing facility or point of export via truck, rail and barge	yes	yes	yes	yes
3	Elevation	Storage of soybeans at country elevators and river elevators. Storage at processing facilities and at ports captured under steps 4 and 7, respectively.	yes	yes	yes	yes
4	Crushing	Crushing soybean seed for the manufacture of crude soybean oil and soybean meal	yes	yes	yes	yes
5	Refining	Refining crude soybean oil for use in edible applications	yes	yes	yes	yes
6	Biodiesel production	Production of biodiesel using soybean oil feedstock	yes	yes	yes	yes
7	Impact at ports	Loading ocean-going vessels for overseas export	yes	yes	yes	yes
8	Feed milling	Value added to soy meal in feed compounding, processing and packaging	yes	yes	yes	yes
9	Long-range rail delivery	Rail delivery of seed, crude oil, refined oil, meal or biodiesel to end user or point of export	yes	yes	yes	yes
10	Long-range barge delivery	Barge delivery of seed, crude oil, refined oil, meal or biodiesel to end user or point of export	yes	yes	yes	yes
11	Savings for livestock sector	Cost savings associated with fulfilling livestock protein demand with soymeal rather than meal alternatives	yes	no	no	yes
12	Limited end-use	Economic impact from soy oil use in select end products where it comprises primary ingredient like margarine, shortening and salad oil.	yes	yes	yes	yes

Tables 2 through 4 present direct economic impacts by step in the value chain in terms of economic, employment, and wage effects, respectively. Tables 5 through 7 display the same data for total impacts.

Regardless of the metric being analyzed, **soybean production represents by far the most important step across the soybean value chain in terms of its broader impacts on the overall economy**. The reason for this is two-fold:

- First, the importance of production across the value chain is a reflection of a methodological choice made in this study. For practical reasons, we needed to defined boundaries for the analysis. Rather than extending explicit breakouts for all inputs into soybean production (land, crop protection, seed technology, fertilizers, etc.), we chose to capture the impacts of

[3] Activities *upstream* from soybean farming, like production and distribution of fertilizers, crop protection, seed technology and agricultural equipment, are captured under the heading of soybean production and through multiplier effects.

[4] Elevation refers to temporary off-farm storage of the bean for later delivery to processing facilities or export terminals. Grain storage and elevation at processing facilities and ports is captured in steps 4 and 7, respectively.

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these inputs, along with the value added by the farmer under the heading of soybean production. *This stands in direct contrast to steps like crushing and refining, which depict only the value added in the course of the step itself,* rather than value that may have actually been created further upstream, which is the case in soybean production. Put simply, soybean production is the only step in the analysis that does not represent the value added at that stage: instead, it effectively represents cumulative value up to and including the point of soybean production in the chain.

- Second, as the most labor, capital and time-intensive stage in the value chain, in which a valuable agricultural commodity is produced from less valuable inputs, soybean production at the farm level is uniquely positioned to add value as well as to support jobs and wages.

Diagram 7: Volumes and value added for soy products grown & crushed

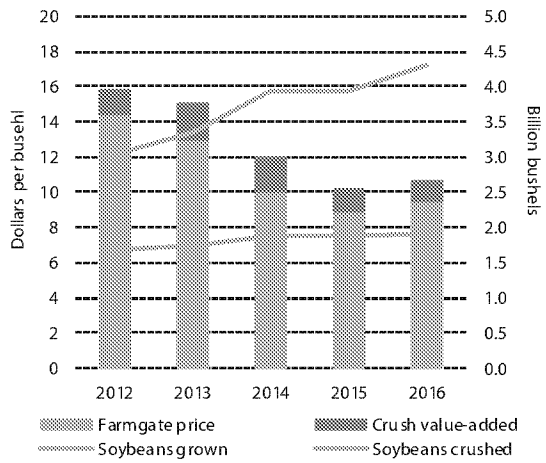
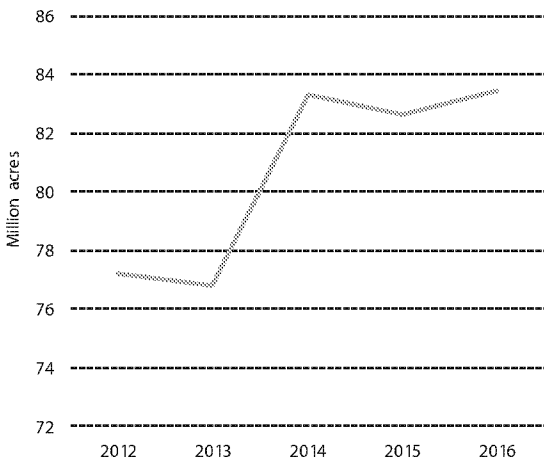


Diagram 8: Planted soybean acres in U.S.



Focusing on total impacts, soybean production, and by extension the activities associated with production and distribution of its inputs, comprised 75% of the soy value chain over the three most recent years of this study. In terms of employment, soybean FTE paid jobs along with non-paid family members accounted for 62% of people supported. Meanwhile, in terms of wages paid, excluding profits or losses made by the farmer, soybean production accounted for a little over half of the soybean value chain.

Table 2: DIRECT economic impacts by step in the value chain ($ Billion)

	2012/13	2013/14	2014/15	2015/16	2016/17
Soybean production	43.7	43.6	39.5	35.2	40.7
Local seed delivery	0.7	0.8	0.9	0.6	0.5
Elevation	0.8	0.9	1.1	1.1	1.2
Crushing	2.4	3.4	3.5	2.3	2.3
Refining	0.7	0.5	0.4	0.3	0.3
Biodiesel production	0.1	0.5	0.2	0.2	0.5
Impact at ports	1.1	2.0	1.3	1.2	1.7
Feed milling	0.6	0.7	0.6	0.5	0.5
Long-range rail delivery	1.6	2.1	2.3	2.2	2.3
Long-range barge delivery	0.3	0.3	0.5	0.5	0.5
Savings for livestock sector	0.0	0.3	1.3	0.8	1.7
Limited food end-use	1.3	1.0	0.8	0.8	0.8
TOTAL	**53.3**	**56.2**	**52.1**	**45.7**	**53.0**

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Table 3: DIRECT employment impacts by step in the value chain

	2012/13	2013/14	2014/15	2015/16	2016/17
Soybean production	48,300	48,200	52,400	51,800	51,800
Local seed delivery	2,300	2,500	2,900	2,900	3,200
Elevation	5,300	5,800	6,800	6,800	7,500
Crushing	2,700	2,700	2,900	2,800	2,900
Refining	1,200	1,200	1,200	1,200	1,200
Biodiesel production	1,400	1,500	1,500	1,500	1,700
Impact at ports	1,000	1,100	1,500	1,700	1,800
Feed milling	6,800	6,800	7,000	7,200	7,400
Long-range rail delivery	2,300	3,300	3,600	3,900	4,200
Long-range barge delivery	100	100	200	200	200
Savings for livestock sector	n/a	n/a	n/a	n/a	n/a
Limited end-use	1,900	1,900	1,800	1,900	1,800
TOTAL PAID EMPLOYMENT (FTE's)	**73,300**	**75,200**	**82,000**	**82,200**	**84,000**
Farm family members	72,400	72,000	78,100	77,300	77,900
TOTAL with FARM FAMILY	**145,700**	**147,200**	**160,100**	**159,500**	**161,900**

Table 4: DIRECT wage impacts by step in the value chain ($ Billion)

	2012/13	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Soybean production	1.63	1.68	1.86	1.91	1.98
Local seed delivery	0.10	0.12	0.14	0.14	0.15
Elevation	0.23	0.26	0.31	0.32	0.37
Crushing	0.12	0.12	0.13	0.13	0.14
Refining	0.08	0.08	0.08	0.09	0.09
Biodiesel production	0.08	0.09	0.09	0.09	0.10
Impact at ports	0.09	0.11	0.15	0.16	0.18
Feed milling	0.27	0.27	0.28	0.29	0.30
Long-range rail delivery	0.16	0.24	0.27	0.30	0.34
Long-range barge delivery	0.01	0.01	0.01	0.02	0.02
Savings for livestock sector	n/a	n/a	n/a	n/a	n/a
Limited food end-use	0.07	0.08	0.07	0.08	0.09
TOTAL	**2.85**	**3.05**	**3.39**	**3.52**	**3.76**

Table 5: TOTAL economic impacts by step in the value chain ($ Billion)

	2012/13	2013/14	2014/15	2015/16	2016/17
Soybean production	98.2	98.1	88.8	79.2	91.6
Local seed delivery	2.2	2.4	2.7	1.9	1.6
Elevation	2.5	2.7	3.2	3.2	3.5
Crushing	7.1	10.2	10.4	6.8	6.7
Refining	2.1	1.7	1.1	1.0	0.9
Biodiesel production	0.4	1.6	0.5	0.6	1.4
Impact at ports	2.0	3.7	2.4	2.3	3.2
Feed milling	1.4	1.6	1.2	1.1	1.1
Long-range rail delivery	2.8	3.6	3.9	3.8	4.0
Long-range barge delivery	0.5	0.6	0.9	1.0	0.9
Savings for livestock sector	0.1	0.9	3.5	2.2	4.5
Limited food **end-use**	2.9	2.3	1.8	1.7	1.8
TOTAL	**122.0**	**129.4**	**120.5**	**104.8**	**121.2**

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Table 6: TOTAL employment impacts by step in the value chain

	2012/13	2013/14	2014/15	2015/16	2016/17
Soybean production	135,000	134,200	145,900	144,600	144,200
Local seed delivery	14,400	16,000	18,600	18,600	20,500
Elevation	31,100	34,400	40,200	40,200	43,900
Crushing	16,300	16,500	17,300	17,200	17,300
Refining	6,100	6,100	6,000	6,200	6,100
Biodiesel production	6,700	7,400	6,800	6,900	7,700
Impact at ports	1,700	2,000	2,700	3,100	3,300
Feed milling	21,000	21,200	21,700	22,500	23,100
Long-range rail delivery	6,500	9,400	10,500	11,300	12,300
Long-range barge delivery	500	500	700	800	900
Savings for livestock sector	n/a	n/a	n/a	n/a	n/a
Limited end-use	6,100	6,000	5,900	6,100	5,900
TOTAL PAID EMPLOYMENT (FTE's)	**245,400**	**253,700**	**276,300**	**277,500**	**285,200**
Farm family members	72,400	72,000	78,100	77,300	77,900
TOTAL with FARM FAMILY	**317,800**	**325,700**	**354,400**	**354,800**	**363,100**

Table 7: TOTAL wage impacts by step in the value chain ($ Billion)

	2012/13	2013/14	2014/15	2015/16	2016/17
Soybean production	5.27	5.42	5.98	6.14	6.39
Local seed delivery	0.45	0.52	0.61	0.60	0.67
Elevation	1.00	1.12	1.33	1.37	1.58
Crushing	0.51	0.52	0.55	0.57	0.60
Refining	0.32	0.34	0.35	0.38	0.39
Biodiesel production	0.29	0.33	0.31	0.31	0.35
Impact at ports	0.16	0.19	0.26	0.28	0.31
Feed milling	0.85	0.86	0.87	0.91	0.94
Long-range rail delivery	0.32	0.47	0.53	0.58	0.67
Long-range barge delivery	0.03	0.03	0.03	0.04	0.05
Savings for livestock sector	n/a	n/a	n/a	n/a	n/a
Limited food **end-use**	0.23	0.24	0.24	0.26	0.28
TOTAL	**9.43**	**10.03**	**11.06**	**11.45**	**12.23**

Note: Totals in Tables 2 through 7 may not add exactly due to rounding.

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State Results

Introduction

In order to calculate national results, local data needed to be collected allowing us to also calculate results for all fifty states as well as select congressional districts. In this section, we present 3-year average results for both direct and total impacts, by state, in Tables 8 and 9, respectively. Because the impacts of certain steps in the value chain, like long-range shipping by rail or barge, cannot be assigned to specific states, the sum of individual state totals is less than the national results presented in the previous section. The difference between the national results and results assignable to individual states is captured in the "unassigned" heading.

Total results, by state, are also presented graphically as maps, for economic impacts (Diagram 11), employment impacts (Diagram 12), and wage impacts (Diagram 13). These maps clearly show that the economic impacts of soybeans are concentrated in the Midwest. Diagrams 9 and 10 illustrate the importance of the Midwest even more explicitly, with Midwestern states being well represented among top states in terms of economic and employment impacts, although this top-tier reflects a strong contingent of states from the Southeast as well.

Results

Table 8: DIRECT results by state – Average 2014/15-2016/17

STATE	Economic	Employment		Wage	STATE	Economic	Employment		Wage
	$ Mil.	Paid Jobs	Farm Family	$ Mil.		$ Mil.	Paid Jobs	Farm Family	$ Mil.
AL	455	860	520	35	**MT**	22	100	-	5
AK	1	-	-	-	**NE**	3,193	4,300	4,390	173
AZ	3	-	-	1	**NV**	1	-	-	-
AR	1,775	3,100	3,530	122	**NH**	0	-	-	-
CA	122	270	-	16	**NJ**	38	100	100	3
CO	37	210	-	11	**NM**	5	-	-	2
CT	1	15	-	1	**NY**	165	400	300	17
DE	94	105	210	6	**NC**	867	1,860	1,940	74
FL	28	105	40	4	**ND**	1,987	3,610	4,625	138
GA	393	685	355	37	**OH**	2,702	4,460	5,275	173
HI	-	-	-	-	**OK**	210	770	465	34
ID	6	85	-	2	**OR**	14	100	-	4
IL	6,106	7,220	8,200	292	**PA**	308	900	640	33
IN	3,482	4,530	4,600	184	**RI**	0.4	2.5	-	0.1
IA	6,210	8,620	8,065	358	**SC**	190	440	540	19
KS	1,926	3,950	3,655	162	**SD**	2,416	3,540	4,280	140
KY	1,021	1,890	1,990	73	**TN**	806	1,585	1,865	59
LA	1,763	3,400	1,900	191	**TX**	286	1,350	140	60
ME	1	5	-	0.3	**UT**	9	55	-	1
MD	366	580	620	27	**VT**	2	-	-	2
MA	0.4	3	-	0.1	**VA**	398	890	755	48
MI	1,042	1,910	1,915	79	**WA**	198	380	-	20
MN	3,961	6,100	6,215	248	**WV**	25	80	30	2
MS	1,205	3,300	3,045	111	**WI**	967	1,880	1,755	75
MO	2,636	4,960	5,830	195	**WY**	5	6	-	0.3
					Unassigned	2,789	3,876	-	317

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Diagram 9: Distribution of economic impacts across states

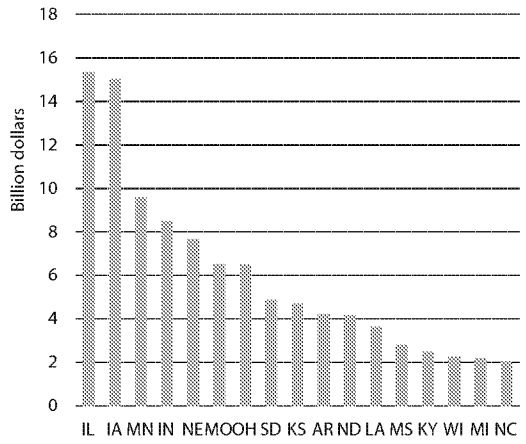

Diagram 10: Distribution of employment (including farm family members) impacts across states

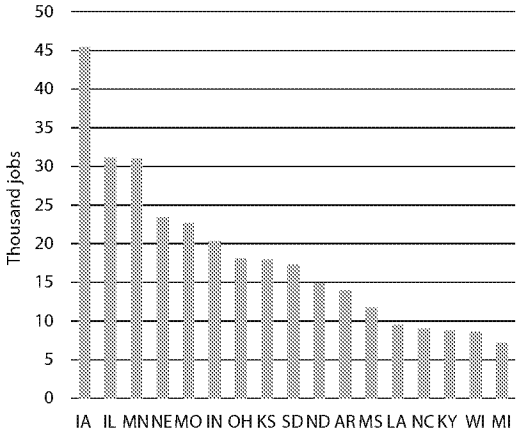

Table 9: TOTAL results by state – Average 2014/15-2016/17

STATE	Economic	Employment		Wage	STATE	Economic	Employment		Wage
	$ Mil.	Paid Jobs	Farm Family	$ Mil.		$ Mil.	Paid Jobs	Farm Family	$ Mil.
AL	1,017	2,570	520	109	**MT**	49	400	-	15
AK	1.3	20	-	0.9	**NE**	7,637	18,920	4,390	651
AZ	6	60	-	3	**NV**	2	10	-	0.4
AR	4,213	10,380	3,530	442	**NH**	0.1	-	-	-
CA	258	740	-	43	**NJ**	75	160	100	8
CO	86	1,040	-	37	**NM**	9	90	-	4
CT	1.4	20	-	1.1	**NY**	287	720	300	36
DE	176	410	210	14	**NC**	2,034	6,960	1,940	249
FL	54	210	40	9	**ND**	4,147	10,230	4,625	433
GA	927	2,450	355	109	**OH**	6,463	12,780	5,275	603
HI	1	-	-	-	**OK**	507	3,180	465	113
ID	14	170	-	6	**OR**	30	310	-	13
IL	15,330	22,870	8,200	1,117	**PA**	650	2,090	640	101
IN	8,461	15,710	4,600	658	**RI**	0.8	10	-	0.3
IA	15,000	37,280	8,065	1,310	**SC**	384	1,310	540	56
KS	4,681	14,190	3,655	579	**SD**	4,859	12,920	4,280	434
KY	2,475	6,720	1,990	263	**TN**	1,737	4,360	1,865	186
LA	3,610	7,530	1,900	441	**TX**	699	4,240	140	199
ME	1.1	20	-	0.7	**UT**	20	110	-	4
MD	651	1,250	620	63	**VT**	3	40	-	1.8
MA	0.6	10	-	0.3	**VA**	771	2,180	755	110
MI	2,173	5,200	1,915	232	**WA**	353	1,130	-	58
MN	9,549	24,790	6,215	911	**WV**	42	160	30	7
MS	2,787	8,660	3,045	374	**WI**	2,223	6,800	1,755	267
MO	6,500	16,730	5,830	697	**WY**	7	10	-	0.6
					Unassigned	4,820	12,132	-	632

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Diagram 11: TOTAL economic impacts by state – Average 2014/15-2016/17

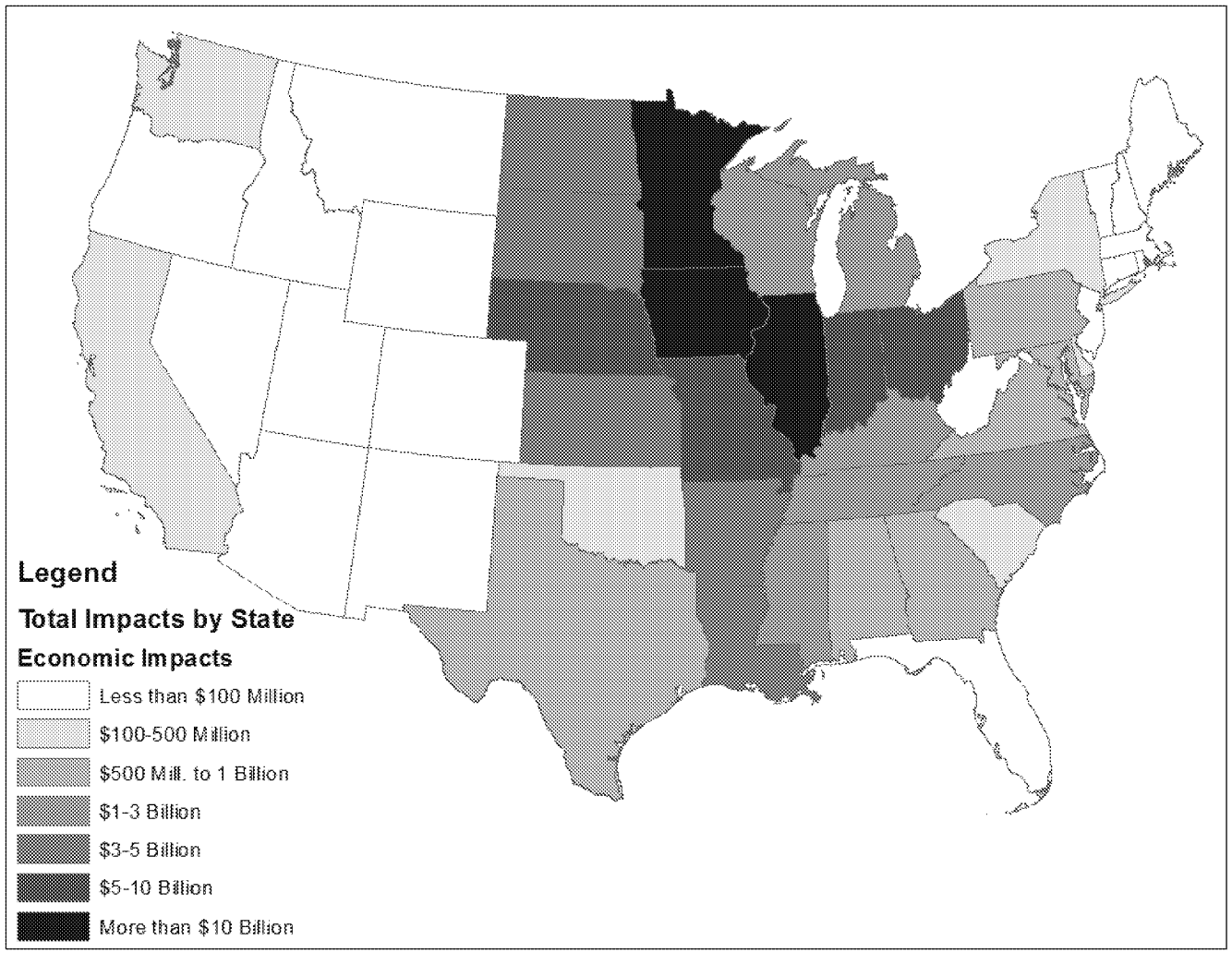

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Diagram 12: TOTAL employment impacts by state, including unpaid farm family members – Average 2014/15-2016/17

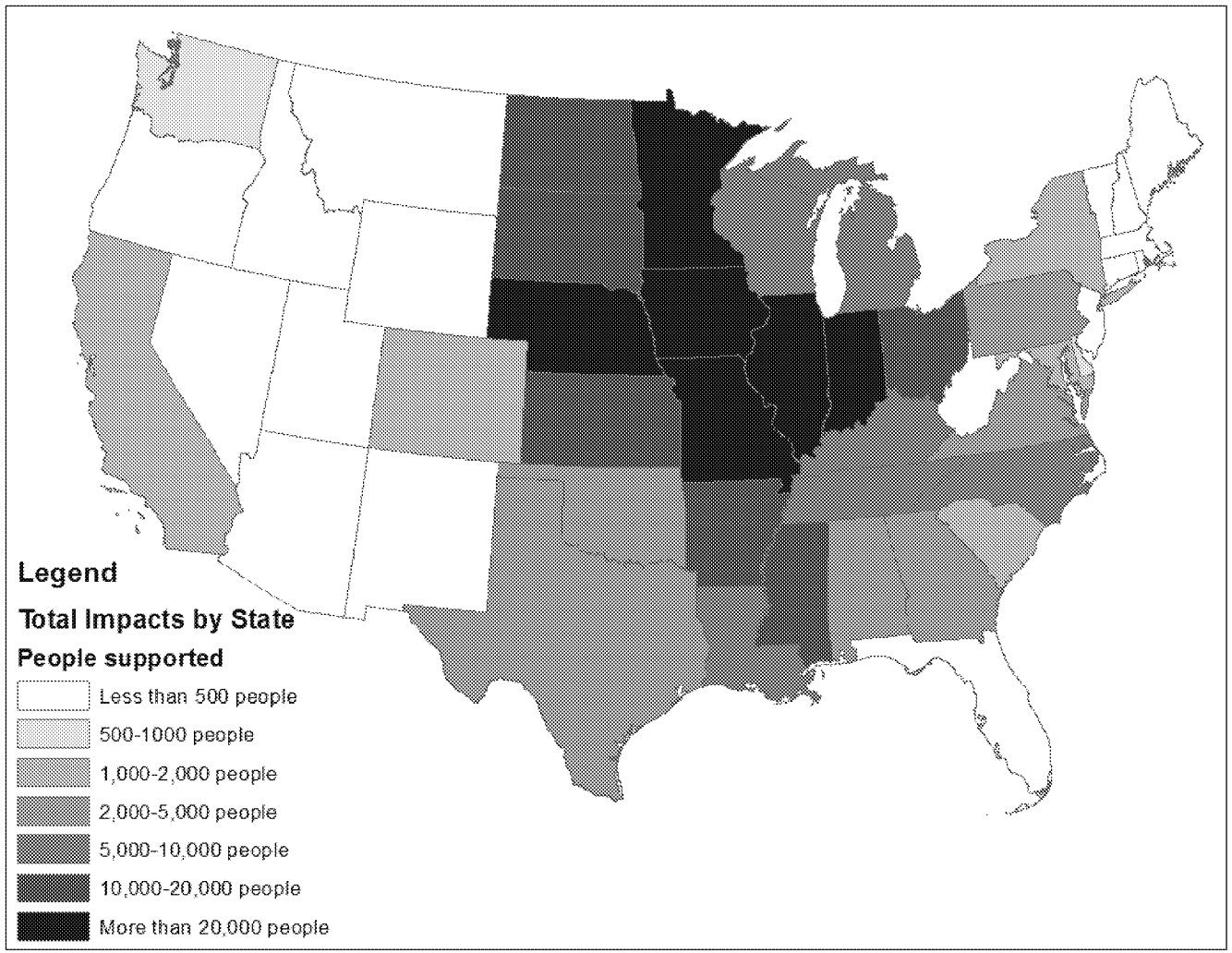

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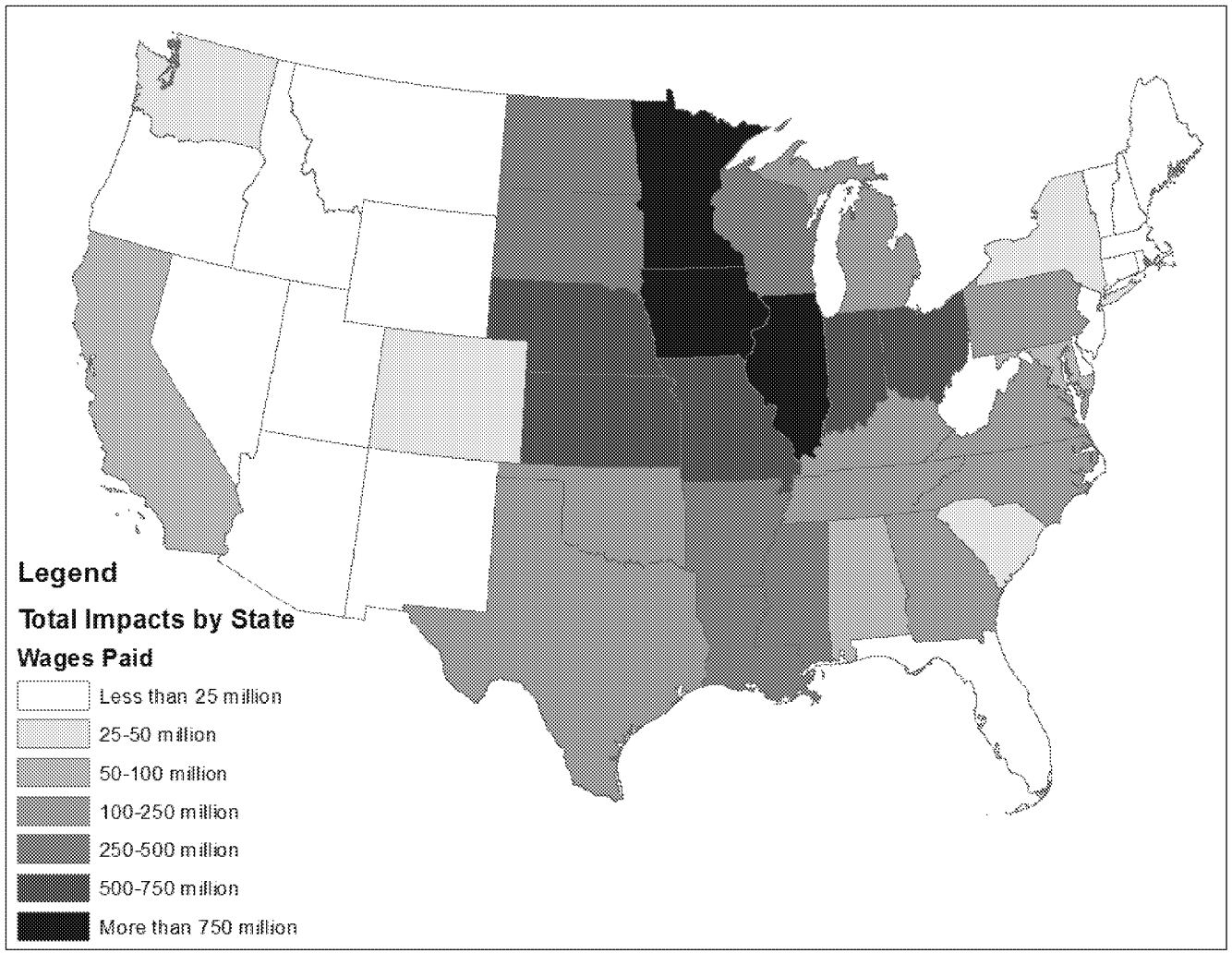
Diagram 13: TOTAL wage impacts by state – Average 2014/15-2016/17



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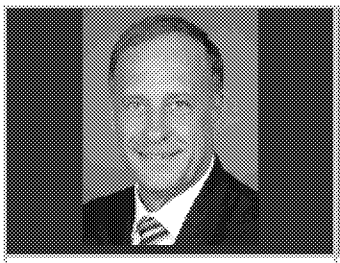
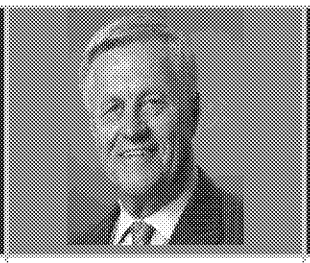
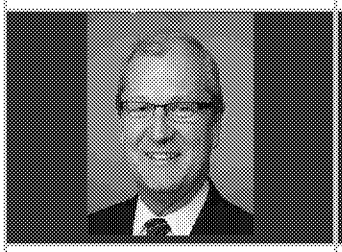
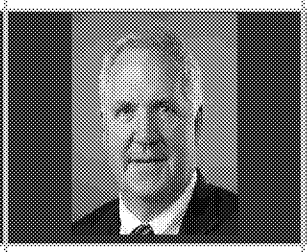
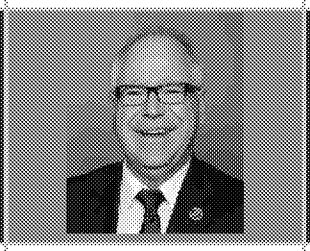
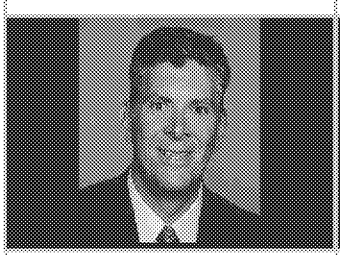
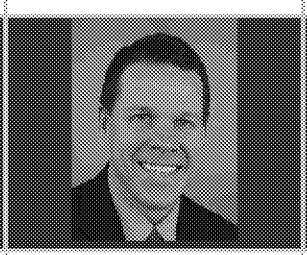
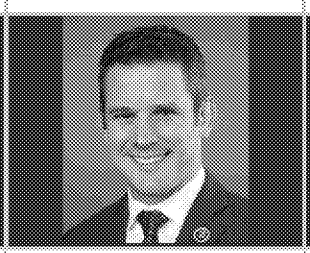
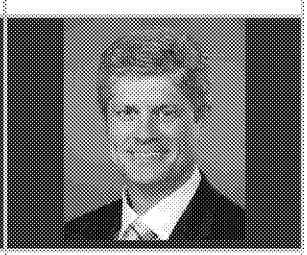
Congressional District Results

Introduction

In the last section, we presented information on the relative importance of states in terms of their contribution to the soybean value chain. Given that these results mirrored very closely the states' relative importance in terms of soybean production and processing, the results would come as little surprise to individuals familiar with the soybean value chain.

In addition to results for all 50 states, we were also asked to present findings for 107 congressional districts selected by the USB and NOPA. In the course of this pursuit, a more nuanced picture of the U.S. soybean value chain emerges. Direct impacts for the 107 selected districts are presented in Table 11, with total impacts delineated in Table 12 as well as presented graphically in Diagrams 14-16. Representatives for the top 12 districts, meanwhile, are presented in Table 10.

Table 10: Representatives for top congressional districts contributing to soy value chain

			
Steve King- IA 4	Colin Peterson-MN 7	Adrian Smith-NE 3	Kristi Noem-SD AL
$ Bil. • $7.5	• $4.9	• $4.8	• $4.6
• 23,100	• 16,100	• 14,700	• 16,600
Mil. • $680	• $440	• $400	• $410
			
Kevin Cramer-ND AL	John Shimkus-IL 15	Tim Walz-MN 1	Rick Crawford-AR 1
$ Bil. • $4.2	• $4.0	• $3.6	• $3.5
• 14,900	• 7,800	• 10,600	• 12,300
Mil. • $430	• $270	• $330	• $390
			
Darin LaHood-IL 18	Sam Graves-MO 6	Adam Kinzinger-IL 16	Jeff Fortenberry-NE 1
$ Bil. • $3.3	• $2.8	• $2.7	• $2.7
• 6,100	• 9,700	• 5,300	• 7,900
Mil. • $220	• $300	• $190	• $220

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Results

Table 11: Direct impacts by congressional districts – 2014/15-2016/17

District	Economic	Employment		Wage	District	Economic	Employment		Wage
	$ Mil.	Paid Jobs	Farm Family	$ Mil.		$ Mil.	Paid Jobs	Farm Family	$ Mil.
AL - 4	140	200	150	10	**MS - 3**	80	140	90	10
AL - 5	150	250	180	10	**MO - 3**	160	330	380	10
AR - 1	1,500	2,710	3,160	110	**MO - 4**	470	890	1,020	40
AR - 2	40	90	100	0	**MO - 5**	200	370	400	10
AR - 4	180	240	250	10	**MO - 6**	1,140	2,160	2,560	80
DE - 0	94	105	210	6	**MO - 7**	80	140	50	10
GA - 8	90	140	70	10	**MO - 8**	580	1,170	1,410	50
GA - 9	110	130	10	10	**NE - 1**	1,100	1,430	1,510	60
IL - 2	100	130	160	10	**NE - 3**	2,020	2,670	2,840	110
IL - 12	310	420	560	20	**NY - 23**	30	80	70	0
IL - 13	860	920	950	40	**NY - 24**	30	60	70	0
IL - 14	130	160	180	10	**NY - 27**	40	90	100	0
IL - 15	1,650	1,870	2,470	70	**NC - 1**	140	330	380	10
IL - 16	1,060	1,190	1,370	50	**NC - 3**	190	400	530	10
IL - 17	630	770	860	30	**NC - 4**	30	50	10	0
IL - 18	1,300	1,400	1,610	60	**NC - 7**	160	320	370	10
IN - 1	80	110	120	0	**NC - 8**	30	50	60	0
IN - 2	430	510	520	20	**NC - 9**	120	220	190	10
IN - 3	440	680	660	30	**NC - 13**	20	50	50	0
IN - 4	880	960	1,060	40	**ND - 0**	1,987	3,610	4,625	138
IN - 5	250	280	360	10	**OH - 2**	130	230	300	10
IN - 6	620	780	860	30	**OH - 4**	620	990	1,160	40
IN - 8	540	680	760	30	**OH - 5**	800	1,300	1,570	50
IN - 9	160	200	250	10	**OH - 6**	50	110	90	0
IA - 1	1,050	1,390	1,420	60	**OH - 7**	160	300	360	10
IA - 2	930	1,250	1,400	50	**OH - 8**	250	370	480	10
IA - 3	1,060	1,330	1,250	60	**OH - 10**	100	160	190	10
IA - 4	3,140	4,320	3,990	180	**OH - 12**	120	200	270	10
KS - 1	820	1,820	1,670	80	**OH - 15**	290	440	580	20
KS - 2	640	1,130	1,450	50	**OH - 16**	30	60	70	0
KS - 4	290	620	500	30	**OK - 2**	70	180	130	10
KY - 1	570	990	1,230	40	**OK - 3**	120	570	250	20
KY - 2	320	490	500	20	**PA - 4**	30	110	70	0
KY - 4	50	130	120	10	**PA - 16**	30	60	30	0
LA - 3	30	120	110	0	**SC - 5**	40	90	50	0
LA - 4	50	160	150	10	**SC - 6**	50	130	180	10
LA - 5	570	1,550	1,490	50	**SC - 7**	60	170	260	10
LA - 6	40	130	120	0	**SD - 0**	2,416	3,540	4,280	140
MD - 1	300	470	440	20	**TN - 4**	70	140	140	10
MI - 2	70	130	60	10	**TN - 6**	60	130	130	10
MI - 3	80	130	170	10	**TN - 7**	130	240	320	10
MI - 4	210	340	420	10	**TN - 8**	500	910	1,190	30
MI - 5	60	100	130	0	**VA - 1**	60	140	180	10
MI - 6	120	190	220	10	**VA - 2**	110	240	80	20
MI - 7	230	360	460	10	**VA - 4**	60	170	220	10
MI - 8	40	60	80	0	**VA - 5**	40	100	130	0
MI - 10	170	270	340	10	**WI - 1**	90	170	150	10
MN - 1	1,440	1,960	1,730	80	**WI - 2**	180	310	280	10
MN - 2	140	270	200	10	**WI - 3**	220	420	410	20
MN - 6	100	150	170	10	**WI - 5**	70	140	130	10
MN - 7	2,130	3,200	3,940	120	**WI - 6**	140	280	260	10
MN - 8	90	210	160	10	**WI - 7**	170	400	340	20
MS - 1	170	580	570	20	**WI - 8**	90	190	190	10
MS - 2	930	2,420	2,370	80	**Other**	6,700	13,800	2,800	780

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Table 12: TOTAL impacts by congressional districts

District	Economic	Employment		Wage	District	Economic	Employment		Wage
	$ Mil.	Paid Jobs	Farm Family	$ Mil.		$ Mil.	Paid Jobs	Farm Family	$ Mil.
AL - 4	310	620	150	20	**MS - 3**	200	400	90	20
AL - 5	340	860	180	40	**MO - 3**	390	950	380	40
AR - 1	3,540	9,160	3,160	390	**MO - 4**	1,180	3,040	1,020	130
AR - 2	100	280	100	10	**MO - 5**	500	1,400	400	60
AR - 4	440	780	250	30	**MO - 6**	2,790	7,180	2,560	300
DE - 0	176	410	210	14	**MO - 7**	230	640	50	20
GA - 8	200	510	70	20	**MO - 8**	1,370	3,770	1,410	160
GA - 9	270	550	10	20	**NE - 1**	2,660	6,410	1,510	220
IL - 2	260	410	160	20	**NE - 3**	4,800	11,830	2,840	400
IL - 12	750	1,190	560	60	**NY - 23**	60	150	70	10
IL - 13	2,240	3,270	950	160	**NY - 24**	60	100	70	0
IL - 14	320	500	180	20	**NY - 27**	80	160	100	10
IL - 15	4,020	5,360	2,470	270	**NC - 1**	320	1,320	380	40
IL - 16	2,680	3,950	1,370	190	**NC - 3**	440	1,520	530	50
IL - 17	1,540	2,510	860	120	**NC - 4**	80	220	10	10
IL - 18	3,280	4,520	1,610	220	**NC - 7**	390	1,180	370	40
IN - 1	180	350	120	10	**NC - 8**	60	190	60	10
IN - 2	1,090	1,910	520	80	**NC - 9**	300	910	190	30
IN - 3	1,050	2,580	660	110	**NC - 13**	40	180	50	10
IN - 4	2,160	3,390	1,060	140	**ND - 0**	4,147	10,230	4,625	433
IN - 5	570	890	360	40	**OH - 2**	310	560	300	30
IN - 6	1,480	2,670	860	120	**OH - 4**	1,520	3,010	1,160	140
IN - 8	1,280	2,260	760	90	**OH - 5**	1,920	3,780	1,570	170
IN - 9	370	590	250	30	**OH - 6**	110	300	90	10
IA - 1	2,490	5,920	1,420	210	**OH - 7**	380	760	360	40
IA - 2	2,160	5,180	1,400	180	**OH - 8**	590	910	480	50
IA - 3	2,640	6,050	1,250	210	**OH - 10**	240	490	190	20
IA - 4	7,540	19,120	3,990	680	**OH - 12**	290	500	270	30
KS - 1	2,000	6,820	1,670	270	**OH - 15**	680	1,120	580	60
KS - 2	1,510	3,710	1,450	150	**OH - 16**	80	140	70	10
KS - 4	760	2,540	500	110	**OK - 2**	160	530	130	20
KY - 1	1,340	3,350	1,230	130	**OK - 3**	290	2,470	250	90
KY - 2	820	2,010	500	80	**PA - 4**	70	270	70	10
KY - 4	120	480	120	20	**PA - 16**	60	170	30	10
LA - 3	70	290	110	10	**SC - 5**	90	310	50	10
LA - 4	120	360	150	20	**SC - 6**	100	340	180	10
LA - 5	1,300	3,670	1,490	170	**SC - 7**	130	420	260	20
LA - 6	100	340	120	20	**SD - 0**	4,859	12,920	4,280	434
MD - 1	520	920	440	50	**TN - 4**	150	430	140	20
MI - 2	180	560	60	20	**TN - 6**	130	380	130	20
MI - 3	170	340	170	20	**TN - 7**	270	630	320	30
MI - 4	440	900	420	40	**TN - 8**	1,070	2,470	1,190	110
MI - 5	130	270	130	10	**VA - 1**	100	320	180	10
MI - 6	250	520	220	20	**VA - 2**	220	440	80	40
MI - 7	460	1,010	460	40	**VA - 4**	110	380	220	20
MI - 8	80	160	80	10	**VA - 5**	80	220	130	10
MI - 10	350	700	340	30	**WI - 1**	210	630	150	20
MN - 1	3,620	8,850	1,730	330	**WI - 2**	410	1,160	280	50
MN - 2	340	1,230	200	40	**WI - 3**	500	1,440	410	60
MN - 6	220	570	170	20	**WI - 5**	170	490	130	20
MN - 7	4,920	12,200	3,940	440	**WI - 6**	330	1,020	260	40
MN - 8	210	840	160	30	**WI - 7**	390	1,460	340	60
MS - 1	380	1,490	570	60	**WI - 8**	220	680	190	30
MS - 2	2,120	6,410	2,370	270	**Other**	13,100	40,400	2,800	2,000

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Diagram 14: TOTAL economic impacts by congressional district – Average 2014/15-2016/17

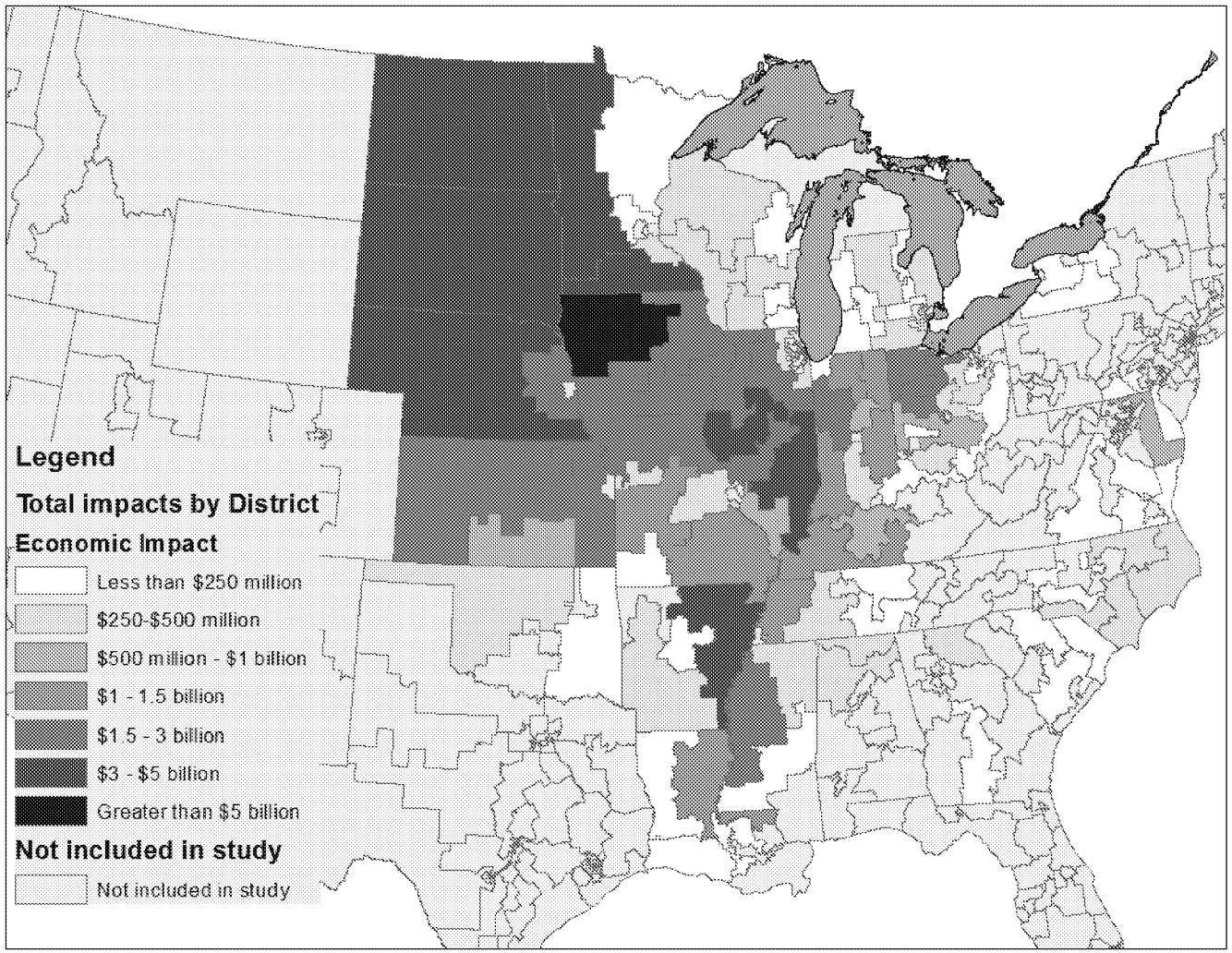

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Diagram 15: TOTAL employment impacts by congressional district, including unpaid farm family members – Average 2014/15-2016/17

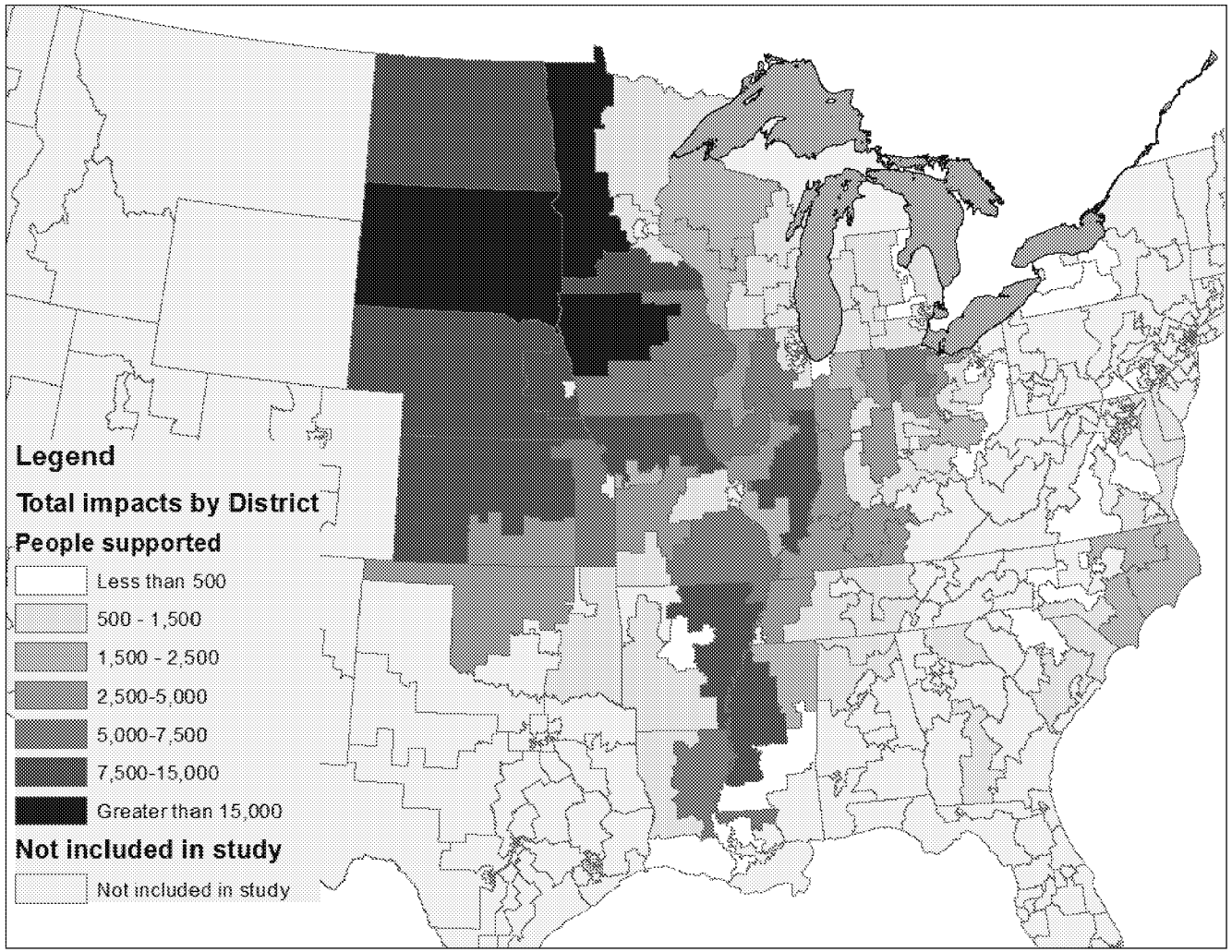

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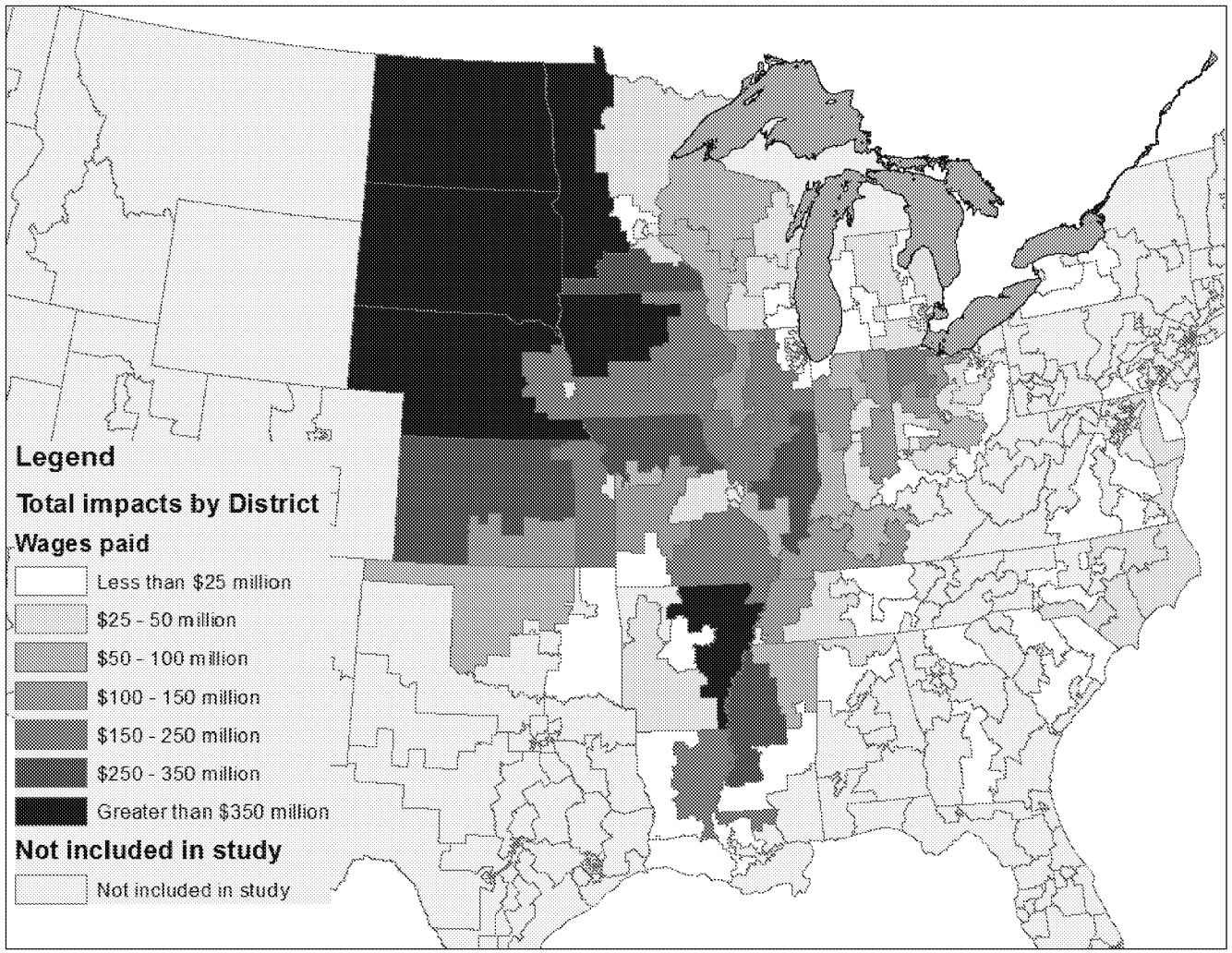
Diagram 16: TOTAL wage impacts by congressional district – Average 2014/15-2016/17



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Overview of Methodology

Summary

The results presented in this study were arrived at first through a manual calculation of **direct** results on the basis of public data sets, stakeholder interviews and LMC industry knowledge, for the value added at all 12 steps in the value chain. **Total** results include *indirect* impacts as well as *induced* impacts associated with household spending, in addition to the *direct* effects. They were estimated by applying economic multipliers to the direct results. We conclude this study by providing an overview of how impacts were calculated, by step, in the soybean value chain.

Production, delivery and elevation

Because it is an input-intensive sector, soybean production by definition supports many upstream industries. These include production and distribution of fuel, fertilizers, crop protection, machinery, water and seed technology, among others. To define boundaries for the analysis to make it a practicable endeavor, rather than attempting to calculate separate impacts for each input sector, they have instead been captured and combined, under the broader heading of "soybean production," along with the value added by the individual farmer.

In this manner, calculating the economic impacts of the production of soybeans becomes a straightforward affair on a per-bushel basis, being equal to the price of soybeans themselves. USDA state-level farmgate price data (Diagram, 17), rather than some kind of delivered cost, was used because impacts associated with transporting beans are captured elsewhere. The direct value added by all soybean production, then, simply becomes a function of soybean price and volume (Diagram 18).

Diagram 17: Range in state soybean prices

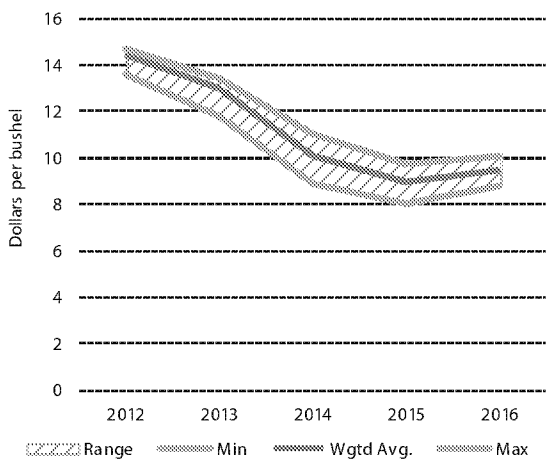
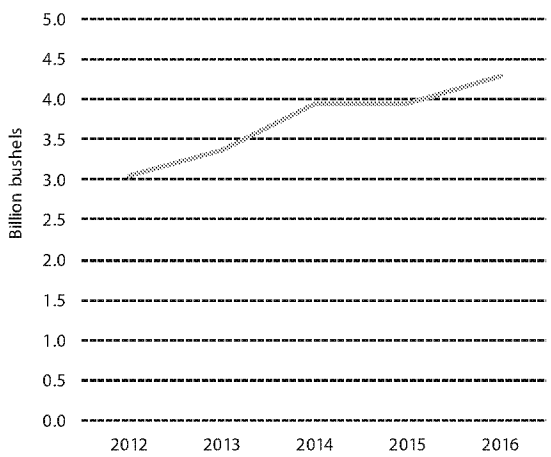


Diagram 18: U.S. soybean production



Although the U.S. Department of Agriculture (USDA) provides data on state and even county-level production, it does not consistently provide this data by congressional district, the fundamental building block of the analysis in this study. To estimate soybean production volumes by congressional district, we took a geospatial approach, overlaying USDA National Agricultural Statistics Service (NASS) cropscape data, which interprets satellite imagery to define commodity production by field, with political boundaries for the 115th Congress of the United States. Using a series of tools available in ArcView GIS, soybean acres were tallied for each of the 107 selected congressional districts. In recent years, these totals have been remarkably accurate, differing from

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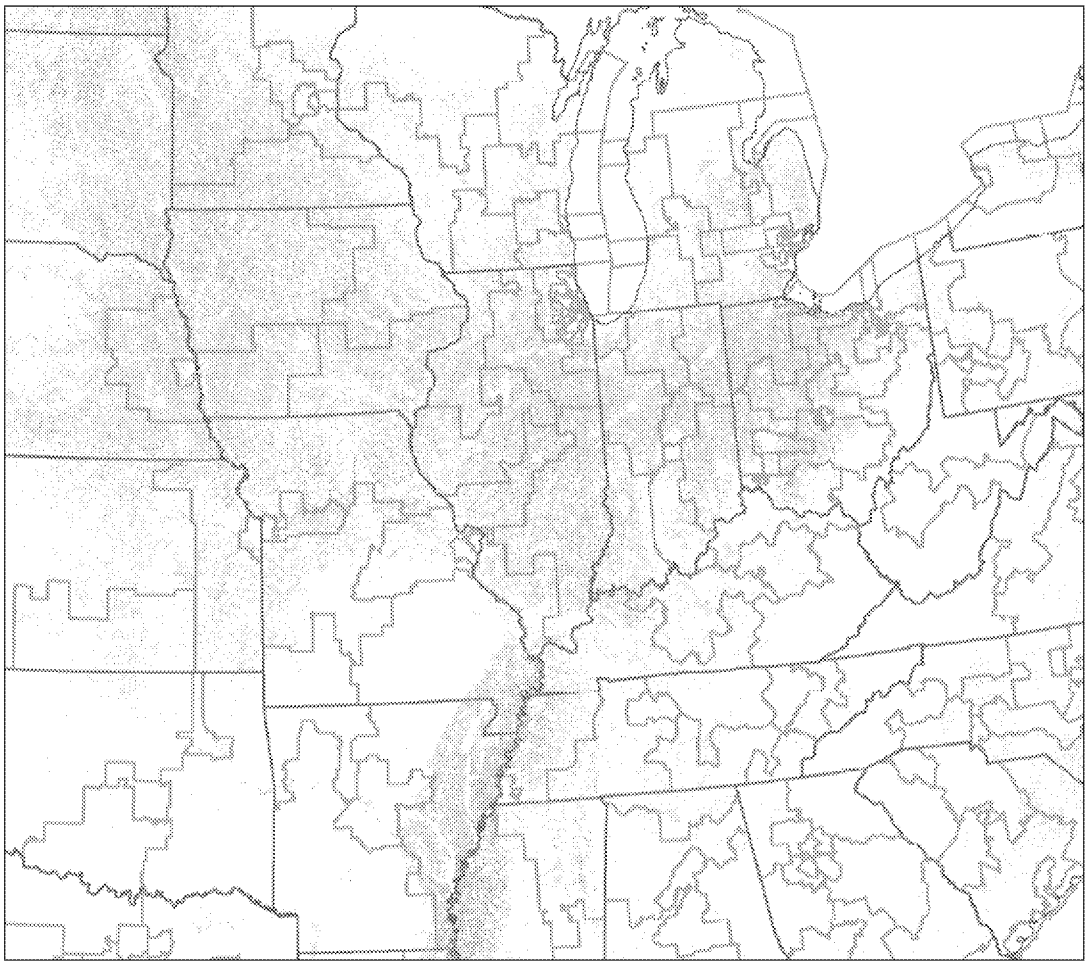
USDA's official national totals by less than 5%. To improve the accuracy of the results of this study, we reconciled congressional district and state totals implied by geospatial analysis to align with official USDA-reported numbers. An example of the data used to perform this geospatial analysis can be seen in Diagram 19.

Diagram 19: Congressional boundaries overlaid with remotely sensed soybean acres (2016/17)



To address the employment and wage impacts associated with soybean production, we began with the USDA Economic Research Service (ERS) budgets that are developed annually for major field crops, including soybeans. These ERS budgets report labor costs for hired labor as well as the opportunity cost of time for unhired labor. These are translated into hours (Diagram 10) using USDA NASS wage data (Diagram 21). ERS budgets also report a cost for Custom Operations, although this includes components other than labor, including machinery, fuel and other inputs. The labor share of Custom Operations costs was assumed to be the same as the share of hired + management labor costs relative to total operating costs (around 15%). This total labor cost of custom operations was then translated to an hour figure by dividing by the hired wage series.

USDA NASS' most recent *Census of Agriculture* in the United States indicates that there are roughly 300,000 farms that report any soybean sales. However, one-third of these farms are run by someone whose primary occupation is other than farming, while 50% of all soybean growers

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derived less than half their income from farming. Even on soybean farms where the owner's primary source of income is farming, a grower's time would be split among other crops. **Throughout this study, all jobs supported are presented on a full-time equivalent basis**, which we define as an individual working 2,000 hours per year. Because of the part-time nature of many growers' soybean-related activities, the full-time equivalent of jobs supported is significantly less than what might be assumed at first blush from the 300,000 figure.

Diagram 20: Soybean per-acre labor requirements

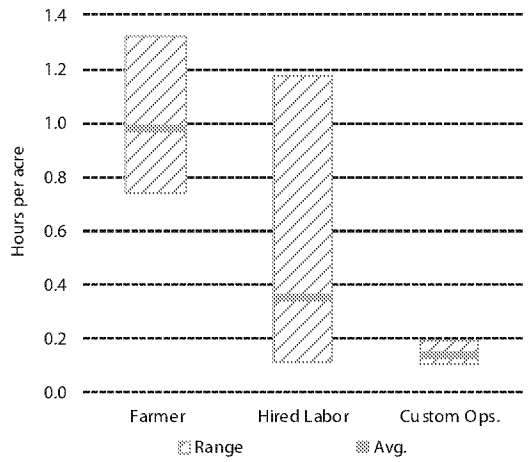
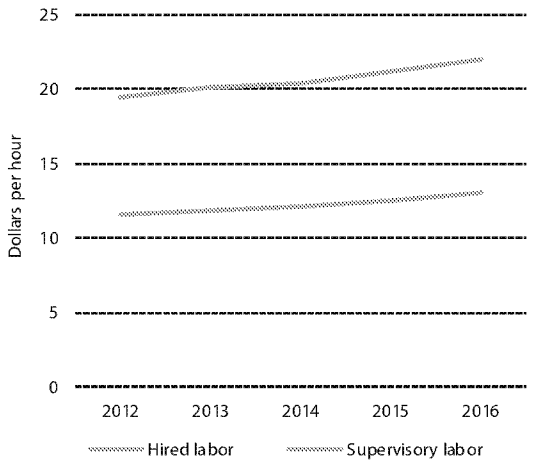


Diagram 21: USDA wage data



After soybeans are grown and harvested, they are most often trucked to an elevation facility and less often trucked directly to a crushing facility. Elevated volumes were modeled on the basis of figures presented in Table 13, which come from a 2012 study funded by USB and the U.S. Soybean Export Council covering U.S. soybean distribution channels, with elevated volumes adjusted each year on the basis of crop size. Value added in elevation was calculated as volume by elevation fee, averaging around 25 cents per bushel during the study period. Jobs associated with elevation came from press releases discussing employment impacts on local elevator closures and openings and these figures were extrapolated for the industry at large. Wages for elevator workers, meanwhile, were assumed to be the same as those for crush plant workers, a series reported by the Department of Labor's Bureau of Labor Statistics (BLS). Finally the geographic breakout of the impact of elevation was modeled on the basis of a USDA database on licensed and unlicensed grain elevators.

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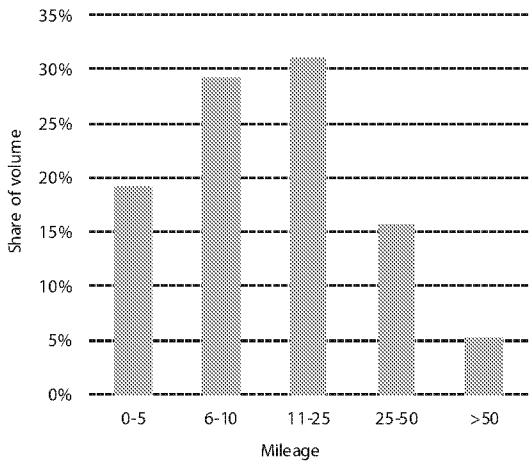
Table 13: Elevations assumed for a 4 billion bushel soybean crop

	Farm-to-market	Farm Storage	Country Elevators	TOTAL
Country Elevator	2,200,000	200,000	0	**2,400,000**
Barge Terminal	200,000	150,000	480,000	**830,000**
Shuttle Elevator	199,400	250,000	672,000	**1,121,400**
TOTAL	**2,599,400**	**600,000**	**1,152,000**	**4,351,400**

Table does not include elevation by processors themselves which is captured under value-added from processing. Deliveries from farm directly to processing plant are estimated to account for between 15-20% of soybean deliveries in recent years.

Diagram 22: Share of local trucking by mileage



Whether beans are being processed domestically or shipped internationally, they first must be trucked off the farm. By moving the bean away from a surplus center and toward the end user, transportation adds value in the process. Diagram 22 illustrates the distribution of trucking distances (one-way) from farms for U.S. soybeans. These distances along with trucking rates reported by USDA Agricultural Marketing Service (AMS) form the basis for the value added in local trucking. The number of jobs supported in local soybean trucking is estimated on the basis of time required to cover these average distances, keeping the full-time equivalent assumption in mind. Trucking wages, like many other wages series used in this study, come from BLS.

Crushing, refining and biodiesel production

Crushing, refining and biodiesel production all represent forms of processing whereby value is added to soybeans and soybean oil, making them logical to address together. The value added in crushing, on a per-bushel basis, was estimated as the value of by-products (oil, meal and hulls) minus the value of whole beans. USDA ERS reported this spread explicitly for the 2015 and 2016 crop years (Diagram 23), based on yields provided by several individual crushers, reported first through NASS, across the U.S., and spot prices for central Illinois reported by the USDA AMS. For 2012-2014, we interpolated results based on the same AMS price series and by consulting with ERS on yields for those years. It is important to note that we were aiming to construct an indicator for the sector as a whole; rather than as an endorsement of the specific experience of any individual crusher.

Value added per bushel was then used in conjunction with total volumes crushed to arrive at a national total for economic impact. This total was then allocated across crush districts on the basis of estimates for crush by plant (Diagram 27) – itself a function of regional crush totals and individual plant capacities.

Economic impacts for soybean oil refined for both edible applications and for biodiesel were calculated in a similar way. In the case of refining, value added per pound was based on the spread for Illinois crude prices, reported by the USDA, and Illinois refined prices, reported by *The Jacobsen*. Volumes refined for edible applications were determined, using USDA data, as use minus exports and domestic use for biodiesel production. Economic impacts of soybean oil refining were calculated as a function of value added per pound and pounds processed. National totals were then allocated across congressional districts on the basis of the soy oil refining capacity of individual plants (Diagram 28).

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Biodiesel impacts were calculated in much the same manner, adjusting for the fact that soybean oil typically accounts for around 50% of biodiesel production annually – data available through the Department of Energy's Energy Information Administration.

Diagram 23: Value added in crushing and volumes processed [5]

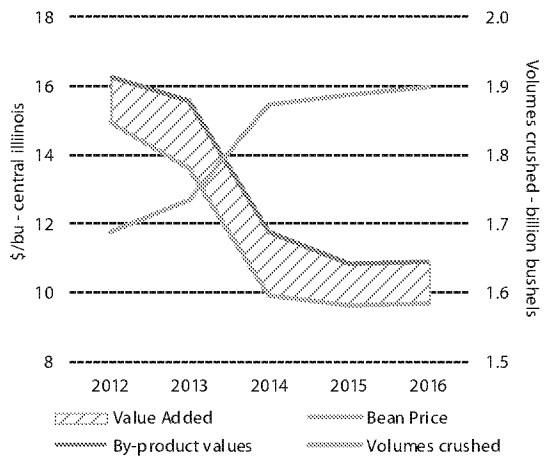
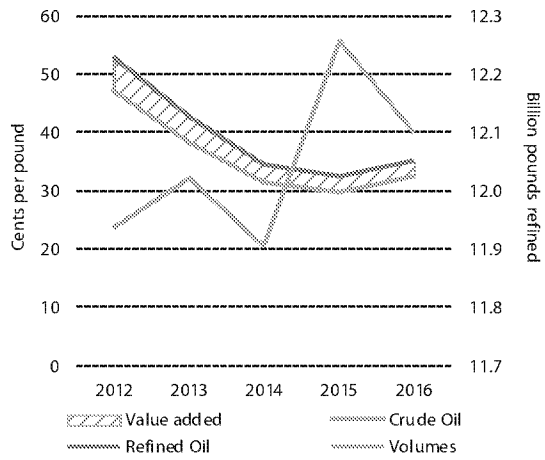


Diagram 24: Value added in refining and volumes processed [5]



Employment impacts were estimated by obtaining employment figures for individual crush plants as well as for refineries through a combination of press reports as well as interviews with select industry stakeholders. This limited cross-section of employment data was then extrapolated to all processing facilities based on known relationships between capacity and individuals employed (Diagram 26). Consistent with other steps in the value chain, employee wage data for crushing and refining was obtained from BLS.

Diagram 25: Value added in biodiesel production and volumes of soy oil processed [5]

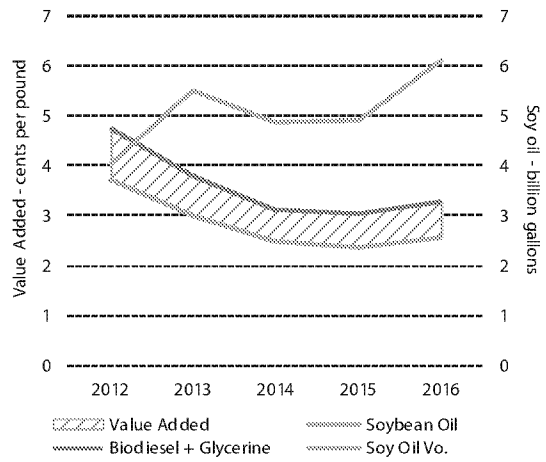
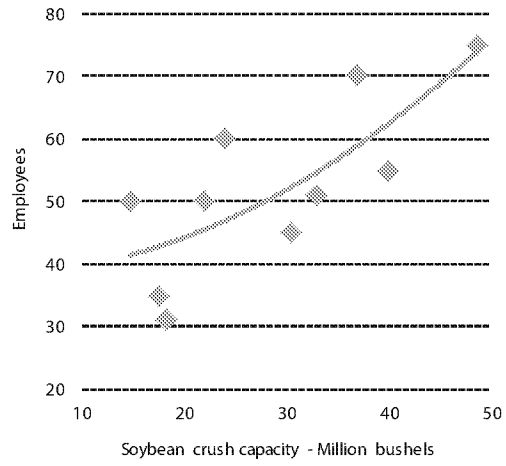


Diagram 26: Staffing estimates for U.S. crush plants by capacity



[5] Value-added is not intended to reflect processor margin, which is subject to many commercial considerations, including timing, risk management and grower relations, much less profitability, which would include costs, beyond the bean as well.

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Diagram 27: Location and estimated average crush (2014-2016) of U.S. soy crush plants

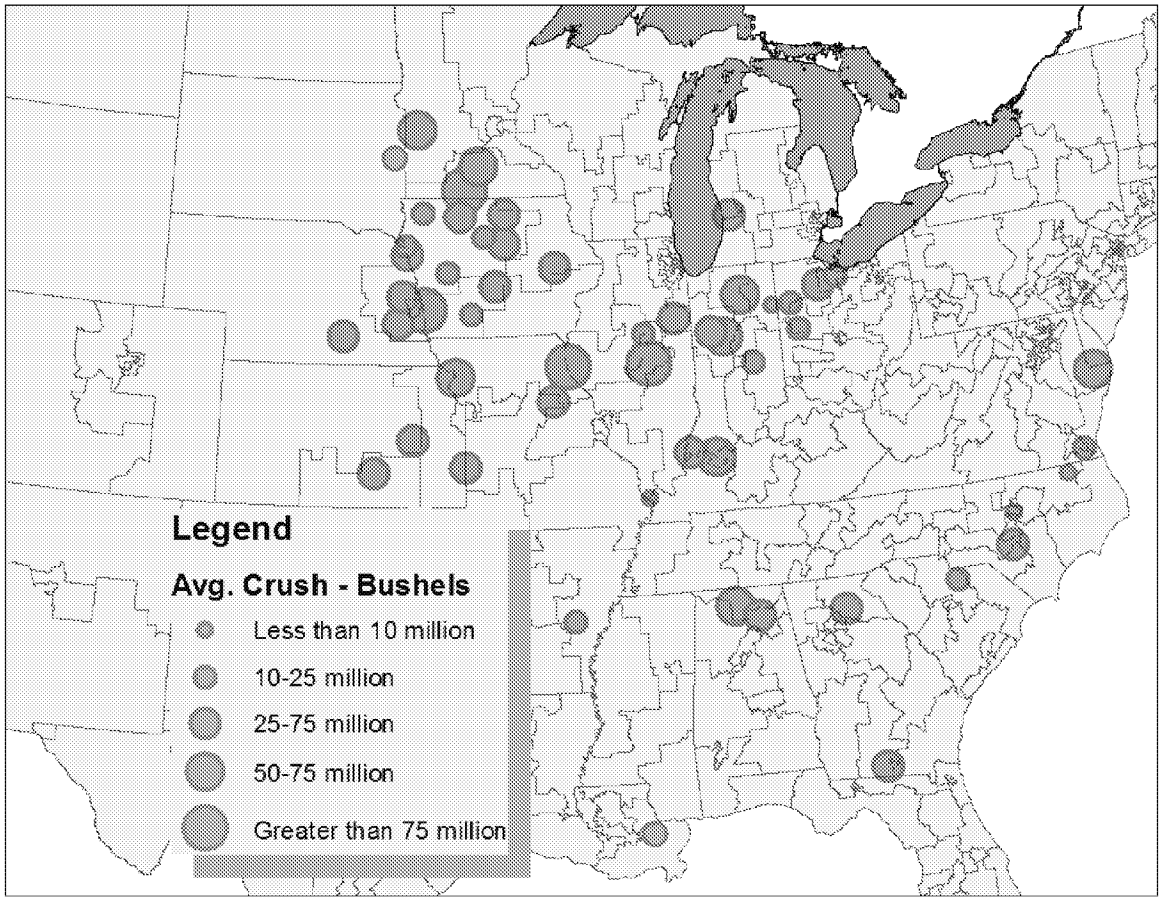

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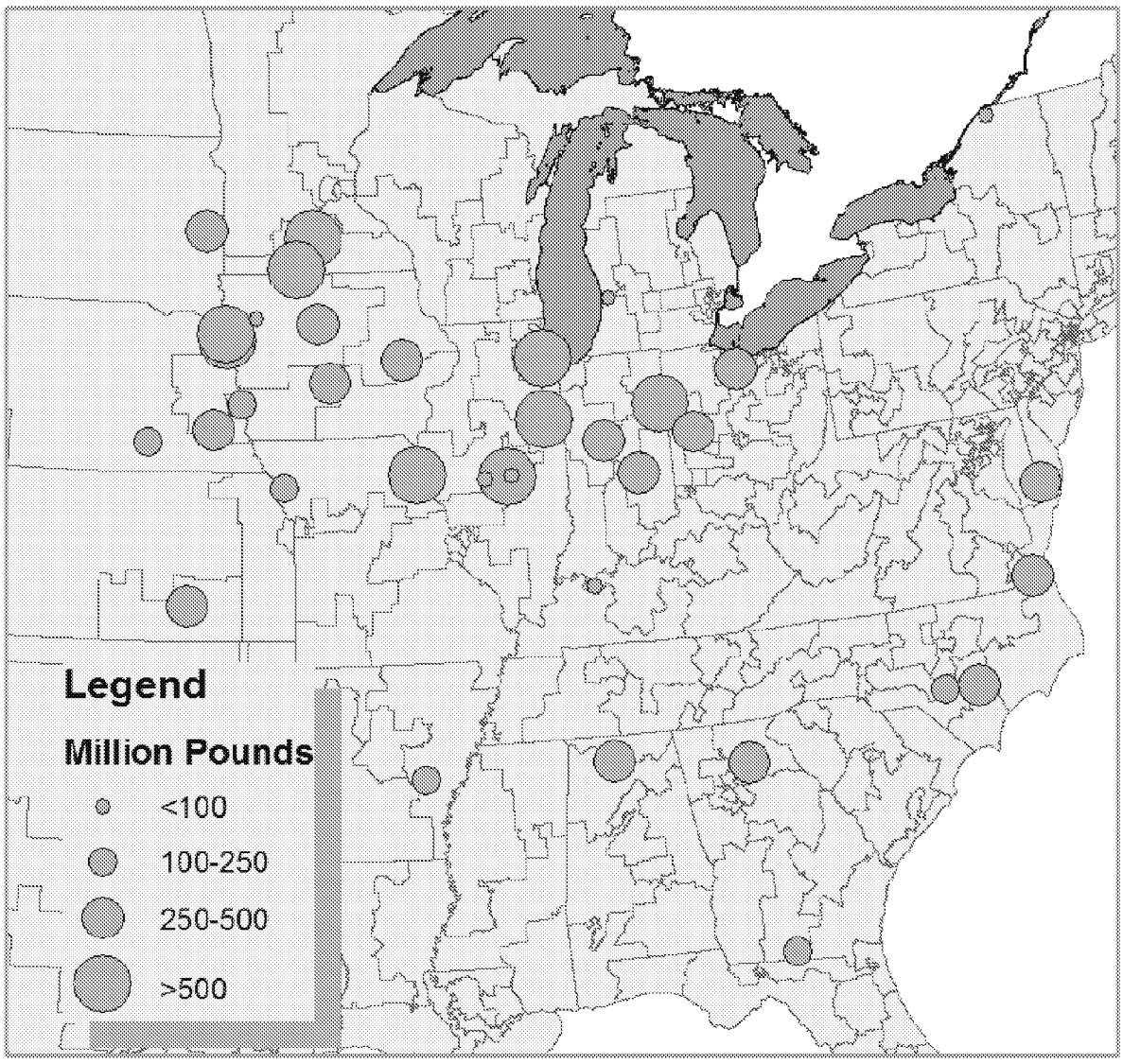
Diagram 28: Location and estimated capacity (2015) of U.S. soy oil refineries



Temporary impacts from new plant construction

Not included in our coverage of impacts associated with soybean processing have been the *temporary* impacts associated with construction of new facilities such as the crush plant recently opened in Conroy, PA (2017) and the ones slated to open in Ithaca, MI and Aberdeen, ND (2019). When multiplier effects are included, construction of these facilities will each support, over the course of two years, between:

- $150-$300 million in economic activity,
- 250-400 jobs, and
- an estimated $25-35 million in wages paid into the surrounding communities.

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Livestock and feed compounding impacts

Essentially, all meal crushed from commodity soybeans is fed to livestock, with about ¾ of domestic production being used within the United States. While animal feed in general and soymeal in particular represent an integral part of livestock production, it is important to recognize that livestock production is a distinct industry, and as such, soybean's claims to economic impact in this domain are inherently limited.

Nevertheless, soymeal does offer and can lay claim to some real benefits to the livestock sector in terms of being *the most competitively priced source of protein for some livestock species*. To assess the value soy offers the livestock sector in this sense, one must first identify livestock species for which it is as good as or better than competing protein sources in meeting an animal's amino acid needs and those species where soy is less competitively positioned. There have been many academic studies on this subject oftentimes presenting contradicting results, or estimating benefits that can be orders of magnitude different. Rather than evaluating the merits of all of these studies, which is beyond the scope of this project, we operated under the assumption that soymeal is generally as good as or better than competing meals in meeting protein needs of all livestock species, aside from dairy.

Operating from this simplifying assumption, we view the benefit of soy as its cost savings relative to the major competing meal, assumed to be canola, on a protein-equivalent basis (Diagram 30) recognizing that the vast majority of canola meal is fed to the dairy sector and that conversely, species like poultry meet the majority of their protein needs through soy. This per-pound savings is then multiplied by congressional level meal use (Diagram 31) for all species, except dairy, to arrive at a figure for economic impact. No employment or wages paid in the livestock sector are credited toward the soy value chain in this study.

Diagram 29: Volumes of soymeal fed to livestock by species

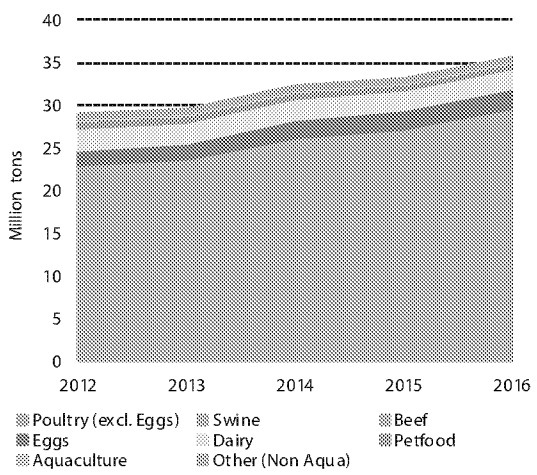
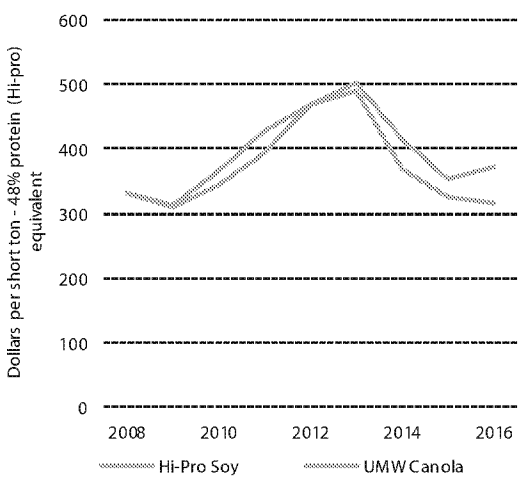


Diagram 30: Protein-adjusted prices for canola and soy meal



At the confluence of the soy and livestock value chains lies feed compounding, and so it has been included in the scope of this study. Conservatively, value added from feed milling was set equal to the spread between loose meal and meal pellets over the observed timeframe. Meal use across jurisdiction, meanwhile, was allocated on the basis of a comprehensive feed mill list maintained by the U.S. Food and Drug Administration. Employment and wage data associated with feed milling was obtained from BLS and this figure was adjusted downward to reflect the fact that soymeal is but one ingredient used in feed milling.

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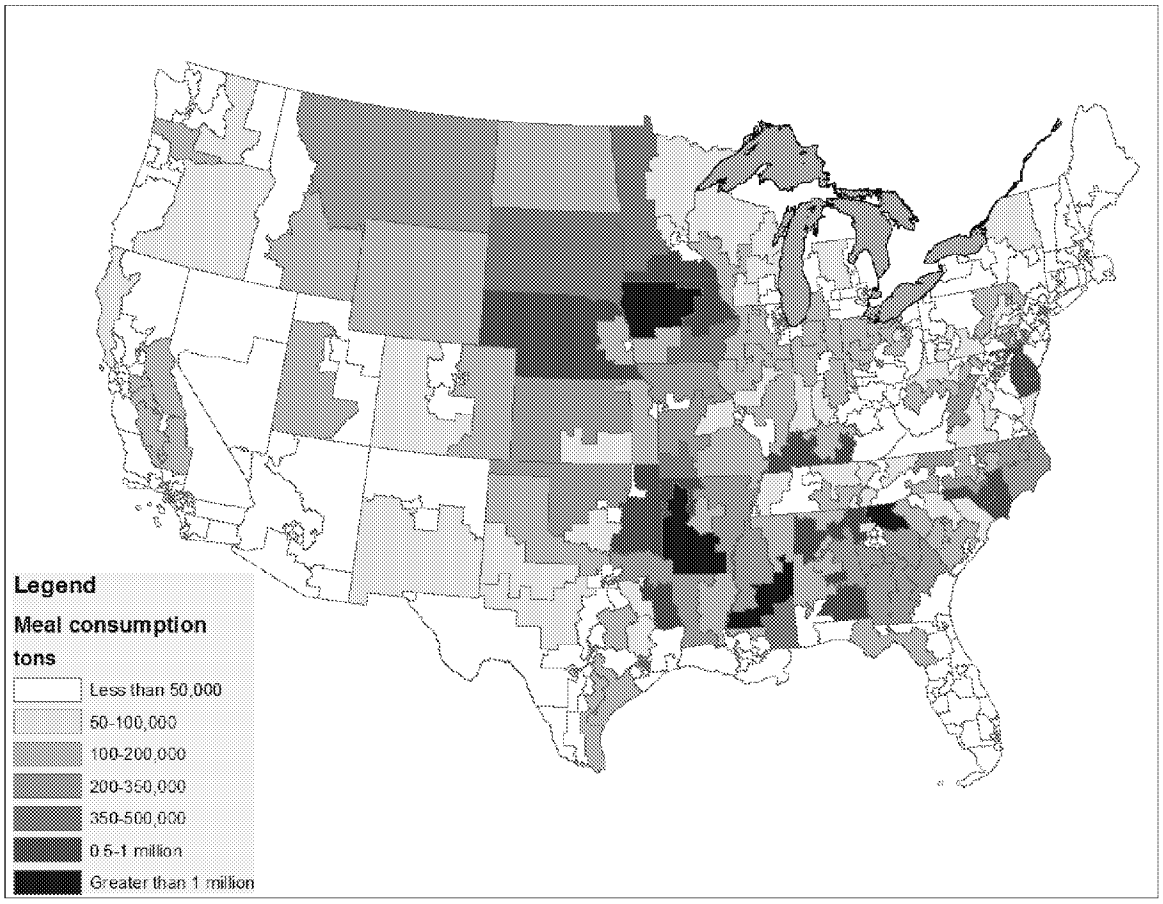
Diagram 31: Meal use by congressional district



Long-range transportation and port activities

Many of the soybean products produced in the U.S. must travel great distances to reach the customer. This long-range transportation can take several forms:

- Arguably, the longest distances would be from the country's heartland to points of export for international destinations – a well-traveled route for all soy products, which can take place by barge or by rail.
- At slightly lesser distances would be shipments of refined vegetable oil and biodiesel from processing facilities in the Midwest to population centers on the coasts.
- Below this, in terms of distance, would be meal shipments from crush plants to livestock consumption centers in the West and in the Southeast.
- Finally, even though it happens less frequently, beans can, on occasion, travel long distances to be crushed and crude oil, to be refined.

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Diagram 32: Rail volumes by soy product

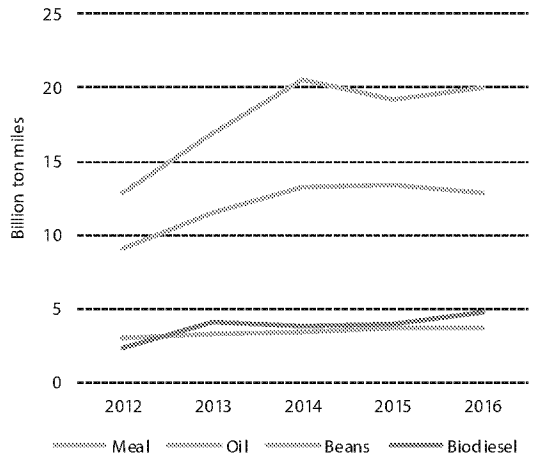


Diagram 33: Avg. rail rate paid per product

Diagrams 32 and 33 present weigh bill data, by soy product, for volumes and rates, respectively, with value added taken to be as a function of the two. Total rail employment figures, salaries paid and total ton-miles of products shipped were obtained from the Association of American Railroads with soy's share of rail employment taken to be its share of all rail shipments – generally between 0.2-0.3%. Because rail shipments are conducted long range, across a national network, we did not assign the impacts associated with soy shipments to any particular congressional district.

Impacts associated with barge shipments were calculated in much the same way as those associated with rail, albeit with volume data obtained from the U.S. Army Corps of Engineers and rate data obtained from USDA AMS.

Diagram 34: Barge volumes and rates

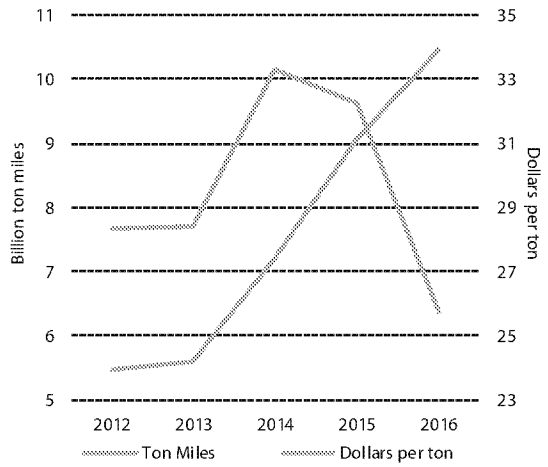
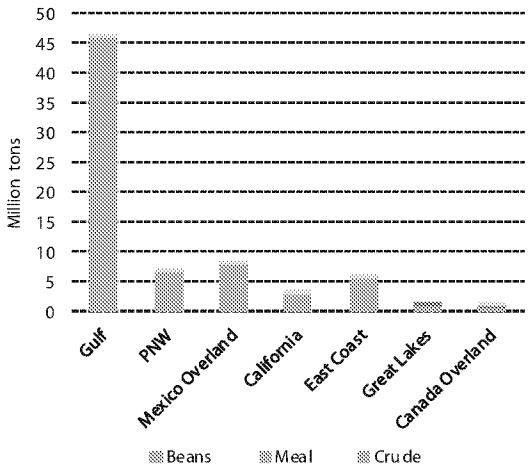


Diagram 35: Exports by port (avg. 2014/15-2016/17)



The final economic impact made by soy products bound for the export market is felt at U.S. ports. Diagram 35 illustrates volumes of soy products moved through U.S. ports combined into 5 regions as well as those volumes that cross overland into Mexico and Canada. This data is made

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available to the public via U.S. International Trade Commission's trade database. Value added at the port was taken to be the spread between the export terminal price and the FOB price[6], data reported by AMS, which ranged between $20-$40 per ton over the 2012-2016 timeframe (Diagram 36). The American Association of Port Authorities has reported total volumes imported and exported through U.S. ports. Soy employment impacts at ports were taken to be a function of the soy share of total port movements and total port employment figures reported by BLS, which also served as the source for wage data.

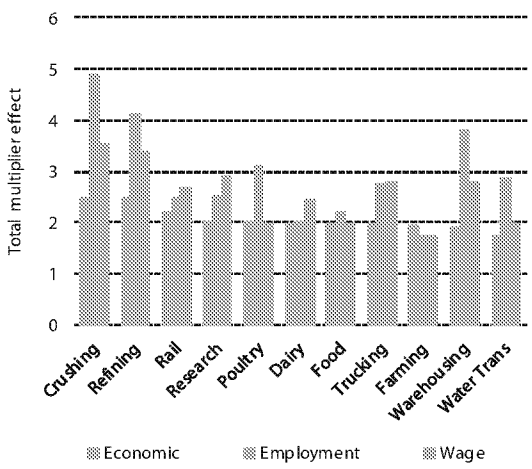
Multiplier effects

As the national results highlight, although the direct effects of the soybean value chain on the broader U.S. economy are significant, they fail to capture the ripple effect that soy has on supporting industries. These are termed the *indirect* effects. For example, the facilities that process soybeans, either through crushing or refining crude into edible oil or biodiesel, may employ only 50-100 people directly, but will employ many more on a contractual basis to keep the capital-intensive facility in working order.

Similarly, direct effects fail to capture the economic activity stemming from expenditures of households drawing a salary from a given sector. While these "*induced* effects" are typically smaller than indirect effects, they can still constitute a sizable economic force, particularly when the sector being evaluated is large, as is the case for soybeans.

Diagram 36: Value added in port activities

Diagram 37: Indirect and Induced (TOTAL) BEA economic multipliers used in this study



For this study, we have used detailed state-level multipliers made available through the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). These multipliers are estimated by the BEA for 369 industries using input-output models, which measure the impact to the broader economy as activity ebbs and flows in a specific sector. The national average multipliers used in this study capturing both indirect and induced effects for key steps in the value chain, are presented in Diagram 37.

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[6] FOB, or free on board, means the price invoiced or quoted by a seller includes all charges up to placing the goods on board a ship at the port of departure specified by the buyer.

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